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EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

EIGHTH ANNUAL REPORT

1935-36

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EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

Report for the Period 1st April, 1935, to 31st March, 1936

STAFF LIST.

Director.—W. Nowell, C.M.G., C.B.E., D.I.C., F.L.S.

Plant Pathologist.—H. H. Storey, M.A., Ph. D.

Entomologist.—T. W. Kirkpatrick, M.A., Dipl. Agric. (Cantab.), F.R.E.S.

Soil Chemist.—G. Milne, M.Sc., F.I.C.

Biochemist.—R. R. Le G. Worsley, A.R.C.S., B.Sc., Ph.D., D.I.C.

Plant Physiologist.—F. J. Nutman, A.R.C.S., M.Sc., D.I.C.

Plant Geneticist.—L. R. Doughty, B.Sc. (Agric.), N.D.A.

Superintendent of Plantations.—F. M. Rogers.

Secretary and Librarian.—R. E. Moreau, C.M.Z.S., M.B.O.U.

Botanist.—P. J. Greenway, F.L.S.

Assistant Superintendent of Plantations.—*Vacant.*

Assistant Secretary and Librarian.—W. M. Nutter.

Engineer-Mechanic.—T. V. Greenwood.

Laboratory Assistant (Plant Path.).—R. F. W. Nichols.

Laboratory Assistant (Soil Chem.).—W. E. Calton, B.A., Dipl. Agric.

Stenographer.—R. Bergner.

STAFF CHANGES.

Mr. R. Bergner appointed Stenographer on 14th September, 1935, vice Miss K. Rushworth on expiration of her agreement.

LEAVE MOVEMENTS DURING THE YEAR.

	Departed.	*Returned.*
Mr. G. Milne	—	21st October, 1935.
Mr. W. M. Nutter ...	18th April, 1935.	30th November, 1935.
Mr. T. V. Greenwood ...	7th May, 1935.	2nd January, 1936.
Mr. L. R. Doughty ...	2nd July, 1935.	9th February, 1936.
Mr. R. F. W. Nichols...	10th August, 1935.	18th January, 1936.
Mr. W. E. Calton ...	30th November, 1935.	—
Dr. H. H. Storey ...	3rd March, 1936.	—

PUBLICATIONS.

The following papers contributed to scientific journals by members of the staff have been treated as Station Memoirs and distributed to our correspondents generally during the year under review :—

21. The Insecticidal Properties of some East African Plants. R. R. Worsley, *Ann. Appl. Biol.*, Vol. 21, pp. 649-669, 1934.

22. Root-systems of *Coffea arabica*, Part III. F. J. Nutman. *Emp. J. Exp. Agric.*, Vol. 2, pp. 293-392, 1934.

23. The Photodynamic Action of Methylene Blue on the Virus of a Plant Disease. H. H. Storey, *Ann. Appl. Biol.* Vol. 21, pp. 588-589, 1934.

24. Some Eco-climatic Data for Closed Evergreen Forest in Tropical Africa. R. E. Moreau, *J. Linn. Soc. Zool.*, Vol. 39, pp. 285-293, 1935.

25. A Synecological Study of the Usambara Mountains, Tanganyika Territory, with particular reference to Birds. R. E. Moreau, *J. Ecol.*, Vol. 23, pp. 1-43, 1935.

26. Cinchona in Amani. R. R. Worsley, *Bull. Imp. Inst.*, Vol. 33, pp. 14-31, 1935.

27. Some Suggested Units of Classification and Mapping, particularly for East African Soils. G. Milne, *Soil Research*, Vol. 4, pp. 183-198, 1935.

28. Studies on the Ecology of Coffee Plantations in East Africa : I. The Climate and Eco-climates of Coffee Plantations. T. W. Kirkpatrick. (Published by the Crown Agents for the Colonies, London, 1935.)

29. A Short Geographical Account of the Soils of East Africa. G. Milne, in collaboration with East African soil chemists, *Trans 3rd Internat. Cong. Soil Sci.*, Vol. 1, pp. 270-274, 1935.

30. Composite Units for the Mapping of Complex Soil Associations. G. Milne, *Ibid.*, pp. 345-347, 1935.

31. A Provisional Soil Map of East Africa. G. Milne, in collaboration with East African soil chemists, *Ibid.*, pp. 266-270, 1935.

32. A Critical Analysis of the Distribution of Birds in a Tropical African Area. R. E. Moreau, *J. Animal Ecol.*, Vol. 4, pp. 167-191, 1935.

The undermentioned papers are awaiting publication or have become available only since the last annual distribution was made :—

The Insecticidal Properties of some East African Plants : 2. *Mundulea suberosa* Bentham, Part I. Insecticidal Properties. R. R. Worsley, *Ann. Appl. Biol.*, in press.

Mundulea Fish Poison. P. J. Greenway, *Bull. Misc. Inf. Kew*, in press.

A Contribution to the Ornithology of Kilimanjaro and Mt. Meru. R. E. Moreau, *Proc. Zool. Soc. London*, 1935, pp. 843-891.

Chromosome Behaviour in relation to Genetics of Agave: I. Seven Species of Fibre Agave. L. R. Doughty, *J. Genet.*, in press.

A new Virus of Maize transmitted by *Cicadulina* sp. H. H. Storey, *Ann. Appl. Biol.*, in press.

Breeding and Moulting Seasons of Birds in East African Evergreen Forests. R. E. Moreau, *Proc. Zool. Soc. London*, in press.

VISITORS.

Official visitors to the Station during the year include Mr. C. F. M. Swynnerton, Director of Tsetse Research, Tanganyika; Mr. B. D. Burtt, Botanist, Tsetse Research, Tanganyika; Mr. E. C. Baker, District Officer, Tanga; Mr. W. F. Baldock, Forestry Department, Tanganyika; Mr. L. A. Markham, Forestry Department, Tanganyika; Mr. M. H. French, Veterinary Department, Tanganyika; and the following members of the Agricultural Departments of contributing territories:—Mr. E. Harrison, C.M.G., Director of Agriculture, Tanganyika; Mr. A. J. Wakefield, Deputy Director of Agriculture, Tanganyika; Mr. S. M. Gilbert, Chief Scientific Officer (Coffee), Tanganyika; Dr. G. B. Wallace, Mycologist, Tanganyika; Mr. R. M. Davies, Senior Agricultural Officer, Tanganyika; Mr. N. R. Fuggles-Couchman, Agricultural Officer, Tanganyika; Mr. R. J. M. Swynnerton, Agricultural Officer, Tanganyika; Mr. N. M. Wight, Agricultural Officer, Tanganyika; Mr. G. W. Lock, Agricultural Officer (Sisal), Tanganyika; Dr. J. D. Tothill, Director of Agriculture, Uganda; Mr. H. Hargreaves, Entomologist, Uganda; Mr. C. G. Hansford, Mycologist, Uganda; Mr. H. R. Hosking, Assistant Botanist, Uganda; Mr. H. B. Waters, Director of Agriculture, Kenya; Mr. J. McDonald, Senior Mycologist, Kenya; Mr. A. C. Maher, Agricultural Officer, Kenya; Dr. E. Martin Case, Biochemist, Coffee Board, Kenya; Mr. L. B. Freeston, O.B.E., Secretary to the Conference of East African Governors, Nairobi.

Overseas visitors include Major R. D. Furse, C.M.G., D.S.O., Colonial Office, London; Sir A. W. Pim, K.B.E., K.C.I.E., C.S.I., Oxford; Mr. S. Milligan, Beaconsfield; Sir Malcolm Hailey, G.C.S.I., C.C.I.E., K.C.S.I., London; Mr. D. W. Malcolm, London; Dr. Ernst Ganz, Switzerland; Mr. E. W. Bovill, London; Prof. R. S. Troup, C.M.G., C.I.E., Oxford; Dr. T. Barbour, Cambridge, Mass.; Dr. J. Ruppel, Berlin; Mr. Noel Krauss, Honolulu, Hawaii; Mr. F. A. Bianchi, Honolulu, Hawaii. (The last two gentlemen are connected with a mission from the U.S. Department of Agriculture, sent to collect parasites of fruit flies in Africa, and have paid several visits to the Station and district.)

REPORT OF THE DIRECTOR.

The period under review has been free from unusual difficulties and disturbances of any kind, and the sectional reports herewith presented provide a concise summary of work and progress in a normal year. Information in greater detail concerning studies which have reached the stage of publication is becoming available at a rapidly increasing rate. The Entomologist has entered the list with a monograph on Ecoclimate, the Soil Chemist as editor, draughtsman, and part-author of the first significant soil map of the combined East African Dependencies, the Geneticist with a first contribution to the cytology of the genus Agave, while the Physiologist has also opened up a new subject by the preparation of a paper on Agave fibres containing the results of several years of investigation.

Perhaps the best evidence that can be offered of the interest and usefulness of the lines of work pursued is the fact that in every section there is felt an urgent need for assistance. The remarks of the Soil Chemist on this subject may be noted as an example, and a case as strong could be stated for the other sections in their respective spheres. In the face of this situation the financial resources of the Station remain the same, except that the proceeds of the levy on officers' salaries are no longer available, while the progression of increments on salaries reduces each year the amount available for general expenses. It is not at present apparent from what direction the necessary relief may come.

At the Agricultural Conference held at Amani in February suggestions were considered for the centralization of agricultural research in East Africa, combining departmental and institutional activities and expenditure. Until a firmer nexus exists between the dependencies concerned, the proposals were not considered to be practicable, even to the extent to which the soundness of the principle might be conceded. There exists, nevertheless, some dispersion of effort which could with advantage be avoided, though not, perhaps, without injury to local feelings.

Sisal Research.

When the Amani programme was first discussed frequent reference was made to the absence, practically complete, of any recorded body of scientific information, from East Africa or elsewhere, concerning the production and qualities of sisal fibre. Provision to meet this situation is well advanced. The plant breeding work and the study of the structure of leaf and fibre undertaken at Amani are now supplemented by agronomic investigation at the Sisal Experiment Station near Tanga, where excellent progress has been made in the design and planting of a comprehensive series of comparative and demonstrational trials. Arrangements for research bearing on the utilization of the fibre have been made with the Linen Industry Research Station at Lambeg in Northern Ireland. These movements, in which the Sisal Growers'

Associations, the Departments of Agriculture and the two research stations are all associated, call for careful co-ordination, and it seems desirable that this should be extended to the private experiments receiving support from the Colonial Development Fund. There is no official provision at present for the investigation of factory equipment and practice, or of the recovery of waste products, both of which are subjects which might very profitably be pursued.

The first result to be expected from the new Experimental Station will be the production, on a scale adequate for agricultural and commercial estimation, of the blue sisal, *Agave amaniensis*. An area of some 17 acres, planted with suckers from Amani in 1935, has made striking progress. The favourable opinion of planters who have observed the results of earlier and smaller trials is shown by demands for planting material in far greater quantity than it can yet be supplied.

The seedlings of *Agave sisalana* which have reached maturity exhibit an astonishing range of variation in their general development, but there is none possessed of improved qualities sufficient to outweigh the disadvantage of the spiny margin which all have developed. Young seedlings of blue sisal, which are being raised in quantity, are to a large extent free from this objectionable feature. The development of various hybrids, now in their early stages, has quite unknown possibilities and will be followed with deep interest.

So far as selection is concerned with fibre qualities it remains at present without clearly defined objectives, since users are not consciously aware of directions in which current supplies might be made more suitable for present needs or adapted to new purposes. It is in this respect that the plant breeder will look to Lambeg for guidance. One obviously possible development would be the production of different types of sisal fibre for different purposes, analogous with the differentiation which has long existed in the cotton trade. At present East African sisal is the product of plants identical in their hereditary characters, differing only in the circumstances of growth and extraction.

During the year there have been requests for information bearing on the subject of grading. We have supplied data which make possible the ready calculation of the relative proportions, by weight or number, of fibres of each length class in leaves of any given length. As even the longest leaves contain fibre varying successively in length down to the minimum which will pass the decorticator, we have expressed the opinion that grading must be based on the hank derived from the individual leaf, a unit readily controlled by the classification of leaf length before or during passage of the machine. An exhibit illustrating the number, length and distribution of the fibres in ordinary and in blue sisal was prepared for the Hard Fibres Exhibition held at the Imperial Institute in March, 1936. The data are included in the paper already mentioned as ready for publication.

Thanks are due to Sir Daniel Hall, Director of the John Innes Horticultural Institute for most valuable facilities given to Mr. L. R. Doughty, during leave, for studies in the cytology of agaves, and to Lieutenant-Colonel Boscawen for generous contributions to the Amani collection of the genus.

Coffee Research.

The Plant Physiologist has pursued during the year investigation of the fundamental physiology of the coffee plant, especially the inter-relations of water uptake, light, the movements of the stomata, and carbohydrate assimilation. Arrangements were made at the end of the period under review for this work to be continued at the Lyamungu Coffee Experimental Station, where a well-equipped physiology laboratory is now available. The *arabica* material bred or selected by the Geneticist is now regularly transferred to Lyamungu for development. The Entomologist resided there for some time early in the year with the object of comparing ecoclimatic conditions and their relation to insect pests with those studied in Kenya. This led to the discovery of a new type of parasite of Antestia, one of the insects most concerned, and the life history of this parasite in relation to the bionomics of its host has since occupied his full attention. This is admittedly a branch from the original line of investigation, but is considered to be justified by its intrinsic scientific interest, as well as the possibility of its bearing on the biological control of Antestia in other areas from which the parasite is absent.

The outstanding problem in coffee research is the estimation of liquoring quality. Concentrated study of this subject by the Biochemist of the Kenya Coffee Board, recorded in the Journal of that body, has left it still obscure, while confirming the conclusions reached at Amani concerning the unimportance of fermentation in the development of quality. The Station has continued to receive and forward, through the Imperial Institute, numerous samples for professional estimation, with no other result than a complete inability to correlate commercial findings with each other or with any of the circumstances of production. So long as no consistent standards of measurement exist, science is helpless, yet the wide differences in value recognized on the market, be they real or imaginary, may affect the growers' returns far more than any of the factors under his control. There is a tendency to assume that good husbandry, in the accepted sense of the term, must improve quality, but examples can be cited which in some respects directly contradict this conclusion.

The first result attained in the experiments with the grafting of *Coffea arabica* on stocks of *Coffea liberica* and *Coffea robusta* are not encouraging, as applied to the problem of successful cultivation of this species in Usambara. The method enables a vigorous stand of young plants to be established, but the experience is that these are still liable to severe dieback when carrying a crop, due, as we

now believe, to carbohydrate depletion. This result may be taken to indicate the reasonable conclusion that the leaf system as well as the root system is an essential factor in the ability of *Coffea robusta* to thrive under the local conditions. How far the difficulty can be met by manurial treatment directed to increase the efficiency of the leaf system, and at what expense, remains to be seen.

Other Crops.

In various quarters much interest has been shown in the prospects which exist for the development of production in three commodities with the study of which Amani has been for several or many years concerned. These are Cinchona bark, Derris root, and Tung oil.

A recent paper by the Biochemist summarizes the information available regarding experience with Cinchona at Amani since 1902. This has been supplemented by visits to the few Usambara estates on which small commercial plantations have existed since the period of German occupation. There is no room for doubt that the district is suited to the growth of Cinchona. Comparison of conditions suggest that other areas equally suitable exist in the East African Dependencies. Seed has been distributed widely from Amani for many years, but initial difficulties in germination and in the seedling stage have prevented development. Skilled horticulture is required, and could be best applied in central nurseries.

The Derris root grown at Amani is the product of plants of *Derris elliptica* originally obtained from Kew. Local conditions have proved highly suitable so far as the limited amount of planting material available has allowed them to be tested, and produce of high quality has been obtained. For this there is evidence of a strong demand. Good progress has been made with the methods of testing insecticidal value, and especially the determination of rotenone. Work on the native African tree, *Mundulea suberosa*, the bark of which gives promise of usefulness parallel to that of Derris root, is still in the experimental stage, and the variations in quality encountered appear to indicate the necessity of selection and of the study of climatic influences.

Previously reported experience with the trees yielding Tung oil has been strongly confirmed. At Amani successive plantings of *Aleurites montana* continue to thrive and the earlier examples to bear normal crops. *Aleurites Fordii* still merely exists, though a few fruits have for the first time been produced. Inquiries made for the occasion of the recent Agricultural Research Conference generally confirm from experience in other parts of East Africa that *Aleurites montana* is much better suited to tropical conditions even at high elevations. This conclusion raises some practical difficulties. Until local supplies become available, which will be a slow process owing to the small initial number of trees, seed is difficult to

obtain. A more permanent problem is the habit of the trees to exhibit a more or less continuous series from some bearing purely male to others bearing purely female flowers. Study of larger numbers over longer periods is necessary clearly to define this tendency and to determine its effect on cropping, but it seems clear that top-working (fortunately found to be possible) will be necessary to provide a satisfactory percentage of heavy bearing trees. Whether selection would be effective depends on factors in the genetic constitution of the species which are not yet known.

More detailed information regarding the East African possibilities of Cinchona, Derris and Aleurites will be found in the report of the conference to which reference is made above and in past and forthcoming numbers of the *East African Agricultural Journal.*

By means of a grant of £5,000 from the Colonial Development Fund, plantations of all three crops are now being established on a scale adequate for commercial demonstration on the Kwamkoro Estate attached to the Research Station. This will also ensure future supplies of planting material. The same opportunity is being taken to make trials of the selected strains of robusta coffee developed at Amani, and to test on a field scale the behaviour of grafted arabica.

Conferences.

An Agricultural Research Conference convened at the direction of the East African Governors' Conference, was held in February, 1936, and was attended by representatives of the Agricultural Departments of Uganda, Kenya and Tanganyika Territory, and of the Amani Research Station. A long agenda was dealt with, containing items concerning organization, plant protection and crop production. The Director of the Research Station presided, and the report is to be issued by the Secretary to the Governors' Conference.

In July, 1935, the first number was issued of the *East African Agricultural Journal*, issued by authority of the Governors' Conference, edited by the Director of the East African Agricultural Research Station, and produced by the Government Printer, Nairobi. Contributions are mainly from official sources, and the Journal provides a much needed means of conveying to the public local information on East African agricultural and related matters.

International Conferences.

The Research Station was represented by Mr. L. R. Doughty, Geneticist, at the International Botanical Congress at Amsterdam, and by Mr. G. Milne, Soil Chemist, at the International Soil Congress at Oxford.

W. NOWELL,
Director.

REPORT OF THE PLANT PATHOLOGIST.

Virus Diseases of Plants.

(a) *The mechanism of the transmission of plant viruses by insects.*

The lines of work mentioned in my last report have been continued during the past year. A solution of the problem of the exact mechanism whereby the insect inoculates the virus into the plant still eludes me. A report upon the results obtained in this study was prepared, in accordance with the intention expressed in my last report. I have, however, refrained from offering it for publication in the hope that further facts might come to light and offer a solution to the difficulties. In fact, although most of my time has been devoted to other studies, the postponement has been justified; I have confirmed certain conclusions, reached earlier but on consideration thought to be not fully proved, and have established some new principles governing the process of inoculation. The present position is that I have collected a large body of data, which have done much to clarify my ideas concerning the process of inoculation and to explain features of the process that were previously obscure. The draft of a paper describing a part of this work is now ready and arrangements for publication will be made during my leave in 1936.

Meanwhile other lines of work upon the general problem of insect transmission have been actively prosecuted. None has, however, yet reached a stage when publication can be considered, although some are nearing completion. Thus the material is largely assembled for several further papers in this series. Pending their completion, however, no point would be served by an account of the work at this stage.

The suspicion concerning the specific determination of the leafhoppers regarded as *Cicadulina zeae*, referred to in my last report, proved to be well founded. After an examination of my material, Mr. W. E. China, of the British Museum of Natural History, reported that two species were concerned—*Cicadulina zeae* and a new species to be described by him under the name *Cicadulina nicholsi*. This discovery has made it necessary for me to augment my evidence upon the inheritance of "activity" (the power to transmit the streak virus) in these two species. As I have previously reported, the breeding of these species is much more difficult than is that of *Cicadulina mbila;* recent modifications of technique have somewhat improved matters, although even now a large number of the pairings made fail to produce families.

At present these studies, as I have reported previously, suggest that the inheritance of activity in *C. zeae* and *C. nicholsi* follows the same plan as in *C. mbila*. Instances of anomalous behaviour have, however, been frequently encountered, and it is primarily with a view to the study of these anomalies that I am continuing breeding work. I hope that thereby I may arrive at an explanation of the aberrant behaviour of certain lines of *C. mbila*, which I reported several years ago.

An apparently new virus affecting maize in the Amani district has been discovered. The disease that it produces is of a very mild character, and is unlikely to be of any economic importance. It is of interest, however, in my present investigations because it is transmitted by the same species of *Cicadulina* as the streak virus, and by active races of these insects alone. This evidence thus throws a somewhat new light on the character of activity, which is now seen to determine the insect's behaviour not only towards the virus of streak disease, but generally towards all viruses with which the species may be related. A paper describing my studies of the new virus has been prepared for publication.

(b) Virus Diseases of Cassava.

The main result of the work on this plant during the past year has been to show that two quite distinct virus diseases are prevalent in the Amani district and probably elsewhere in East Africa. The first is the well-known Mosaic, or Kräuselkrankheit, upon which I and others have done considerable work. The second appears never to have been previously recognized; its chief characteristics are the production of dark brown stripes on the otherwise green stems, and a yellow mottling of the leaves, which develops only during the later stages of the individual leaf's life. The stem-lesions remain as sunken areas when the stem barks over. If badly diseased, the stem becomes very brittle and readily breaks off at ground level. The leaf-mottling is of a different character from that of mosaic; the diseases are readily distinguished furthermore, because, whereas the mosaic pattern is present on young leaves as they unfold, the young leaves in this new disease are normal and only develop the mottle in ageing.

By grafting experiments I have shown that the new disease is transmissible and is independent of mosaic, although both may often occur in the one plant. The insect-vector has not yet been discovered.

There is no reason to believe that this disease has only recently appeared in East Africa. The condition that it produces is one that I have held under suspicion for several years, but hitherto I have not differentiated it clearly from the effects of mosaic and unfavourable cultural conditions. Indeed, the leaf-mottling symptoms are strongly suggestive of a nutritional deficiency and excite no suspicion that they are related to a virus. During the past year, however, a favourable opportunity was encountered for the investigation of this disease, and the evidence of its transmissibility was obtained without difficulty. That the causative agent is a virus is less certain; at present this hypothesis is based mainly on the negative evidence that no visible pathogen has been demonstrated.

The effects of the new disease upon Cassava plants growing during the cool season of 1935 in Amani were extremely severe. The majority of the diseased plants lost all their stems by breakage

and only shootless stumps remained. These observations led me to attribute an exaggerated importance to the disease; for with a rise in temperature the same plants grew away fairly strongly and nearly free from disease symptoms. It seems evident that this disease is one of low temperature manifestation, and that at temperatures most favourable to the growth of Cassava its effects are relatively mild. At the same time it must be remarked that even on the plains the ill-effects are evident during the winter season, even though not so severe as at the higher altitude of Amani. As Cassava is grown throughout the year, the disease is by no means of negligible economic importance.

The study of the local strains of Cassava mosaic virus have been continued. They fall into two clearly marked groups—those that produce a severe yellow mosaic, with extreme distortion of the leaves and general stunting, and a second group that produce only a mild green mosaic, with probably little general ill-effects Although consistent small differences in symptoms are evident between members within each group, I now doubt whether any purpose would be served by an attempt to differentiate them. The attempt, previously reported, to obtain immunity from the severe group of strains by infection with mild strains has definitely failed. My experiments, carried out on an extensive scale, now leave no hope that control of mosaic can be achieved in this way. At the same time, this failure has no bearing on the general hypothesis that one strain of virus may confer immunity from another; for it is merely an assumption, unsupported by experimental evidence at present, that the mild strains are in any way related to the severe strains of the mosaic virus.

Recent studies have thus emphasized the complexity of the problem of virus disease control in Cassava. The prospect of breeding from local Cassava varieties new varieties resistant to mosaic is, as I have previously pointed out, decidedly unfavourable; and the difficulties are greatly augmented if resistance against two independent viruses or groups of viruses (i.e. mosaic and the new stem-lesion virus), must be sought. In the hope of introducing new factors for resistance, Cassava varieties from West Africa, the West Indies and Java have been introduced through quarantine. The only ones yet available for trial—from West Africa—have proved to be fully susceptible to both viruses. A suggestion by the Director of the Imperial Mycological Institute that resistance should be sought in interspecific crosses in the genus *Manihot* is worth following up; but such work would fully occupy the time of a plant-breeder and could hardly be attempted by the present Amani staff.

The experiment designed to study the secondary spread of mosaic in the field, now nearing the end of its second year, has revealed a marked seasonal difference in the rate of spread. This experiment will be completed during 1936.

An exchange of information with Agricultural Departments in West African Colonies has been continued.

(*c*) *Publications.*

I have contributed to the East African Agricultural Journal a series of five articles upon virus diseases of East African plants.

(*d*) *General.*

During half the year my assistant, Mr. R. F. W. Nichols, was absent on leave.

H. H. STOREY,
Plant Pathologist.

REPORT OF THE ENTOMOLOGIST.

As foreshadowed in my report last year, my attention has mainly been devoted to a study of the Strepsipterous parasite of *Antestia*, which was discovered in the coffee plantations on the slopes of Kilimanjaro.

If justification is needed for such a detailed investigation of a single species of insect, it lies not only in the possible economic importance of this parasite, but also in the fact that, since the researches of Nassonow towards the close of last century, very little further information about the habits of these remarkable parasites has been obtained. Moreover, Nassonow's work was confined to Strepsiptera parasitizing Hymenoptera ; even less is known about the " stylopization " of Homoptera, and nothing whatever about that of Heteroptera, apart from two bare records of the occurrence of female parasites in insects of this sub-order.

This species attacking *Antestia* will require the erection of a new family to contain it and, as was to be expected, many particulars of its biology vary greatly from what has previously been ascertained about the biology of species belonging to other families of the order.

Most of the more important features of its life-history, habits and host-relations have already been elucidated. There is, however, a number of points, some of considerable interest, on which further information is now being sought. Some of these are as follows :—

1. *Embryology.*—It is known that a single fertilization by a male parasite, the duration of which may only be a few seconds, is sufficient to enable a female to produce young over a period of at least three months, at an average rate of about 50 per day. Yet living spermatazoa have never been found in the body of a female more than 17 days after it had been fertilized. There are indications that some, but not all, of the eggs develop polyembryonically, and it is possible that those which do so have a longer incubation period, which, if it can be proved, would account for the above facts.

2. Effect of stylopization on the gonads of the male host. With, so far, a single exception in about 50 experiments, it has been found

that a " stylopized " male *Antestia* is incapable of fertilizing a female (though they have been observed to copulate). Even in a heavily parasitized individual, the male organs are not obviously atrophied as are those of the female, and the testes produce active spermatozoa apparently indistinguishable from those produced by an un-parasitized male.

I have, however, an idea that one of the accessory glands of the male genital organs may be affected, and further investigation into this point is now in progress. The single exception referred to above was of a male *Antestia* containing a single parasite, which had not penetrated until the final ecdysis of the host. This male was enclosed with an unstylopized female, which laid three batches of eggs which proved fertile, subsequent batches failing to hatch. " Stylopized " females, it may be noted, never produce viable eggs, and in only three cases out of the considerable number (2-3,000) so far examined, have their atrophied ovaries produced recognizable eggs, and in none of these three exceptions were the eggs deposited.

3. Apparent correlation of *Antestia* having incompletely developed antennae, with immunity to " stylopization ". A very small percentage of *Antestia* bred in the laboratory have mal-formed antennae, the joints being much shorter than normal, and sometimes one or two of them lacking. So far only twelve such individuals have been bred, but all of these have proved immune to attack by the parasite. Such *Antestia* are in all other respects apparently normal, and are able to mate. At present, however, only one opportunity of doing this has occurred, and the offspring of the union have normal antennae. Experiments are in progress to ascertain whether the immunity has been transferred to the apparently normal first generation, and whether the condition of rudimentary antennae is an inherited character.

4. Experiments are being carried out on three varieties (or species) of *Antestia*.—(*a*) *A. orbitalis* West var. *lineaticollis* Stol, which is the commonest Antestia on coffee in East Africa, and the only one in which this parasite has been naturally found. (*b*) on *A. orbitalis* var. *faceta* Germ, which is equally readily attacked by the " Stylops ", and in which they can come to maturity, though (perhaps owing to its smaller size) there is a greater premature mortality among " stylopized " hosts of var. *faceta* than there is among var. *lineaticollis*, and it is doubtful if the parasite could ever become established in *faceta* under field conditions. (*c*) a species or variety the name of which is not yet known, somewhat similar to *faceta* but larger. Although the first-stage larvae of the strepsipteron will on occasion penetrate this variety, and in two individuals have developed to some extent, they do not seem to be able to complete their development in it. It is, however, thought that these three *Antestia* are distinct species, and not merely varieties, as quite apart from stylopization, they seem unable to interbreed, and also show some differences in their bionomics.

5. More information is being sought on the effects of climatic conditions on the host, and through the host on the parasite. A similar investigation into the influence of different food-supplies—coffee berries of varying ages, etc.—is also intended.

It is difficult to assess the value of this parasite as a controlling factor in the districts where it occurs. It seems however safe to assume that a parasite which (at least in one district where fairly frequent counts have been made) renders completely sterile a percentage of the *Antestia* population which varied at different times of the year from about 20 per cent. to over 80 per cent. must at least render the necessity for control measures less frequent than would be the case in its absence. A small supply of the parasites was sent by air to Kenya, where I understand they are being successfully bred in the laboratory, but enough have probably not yet been obtained to attempt liberation in a plantation.

Another, quite different, species of Strepsiptera has been found at Amani parasitizing a common species of *Cicadella* (Jassidae). Although of no economic importance, it had been hoped to make some study of the bionomics of this species for comparison. As yet however no success has attended attempts to breed the host in captivity.

T. W. KIRKPATRICK,
Entomologist.

REPORT OF THE SOIL CHEMIST.

In April last year I reported the completion, in draft, of the Provisional Soil Map of East Africa, compiled in collaboration with my colleagues in Kenya, Uganda and Zanzibar. During part of my remaining stay in England this was prepared in fair copy, with an accompanying memoir, for publication. I understand that it is to leave the printers' hands this month (March, 1936), and be available for distribution in April.

In July-August I attended the Third International Congress of Soil Science at Oxford as official representative of this Station and of Tanganyika Territory. I exhibited the completed manuscript of the soil map, and read papers on East African soils and their classification. In committee with representatives from South and West Africa, the Sudan and Egypt, I assisted in formulating a scheme for the production, by 1940, of a generalized soil map of British Africa on a scale of 1 : 5,000,000, to be edited by Mr. C. G. T. Morison, Reader in Soil Science in the University of Oxford. To the material for this map the present East African one, by that time no doubt added to and amended, will be contributory. I undertook also to participate in building up a permanent collection of African soil types in England.

The soil map was demonstrated later before Section E (Geography) of the British Association at its meeting at Norwich.

I returned from leave on 21st October. Mr. Calton, laboratory assistant, went on leave on 30th November. His analytical work during this half-year provided technical information, chiefly on clay compositions, texture, and base-exchange properties, which will from time to time be worked up along with field data into general accounts of important soil types and regional soil complexes. Amongst the new material he handled particular mention must be made of some collections, sent in by Mr. J. Pitt-Schenkel, Assistant Conservator of Forests, of forest soil profiles from cool moist mountain districts in Usambara and Uzungwa. Some of these show true podsol morphology, and are the first examples of tropical podsol that I have seen.

In November Mr. B. D. Burtt, Survey Botanist to the Tsetse Research Department of Tanganyika, visited Amani to make touch with soil work, and in early December I left with him on a journey to the Central, Western and Lake Provinces. Our purpose was to study the relation of soil conditions to vegetation types in semi-arid areas. In his company I travelled to Mpwapwa via Handeni and Mamboya, thence to Manyoni to visit deciduous thicket and dry forest formations, and to Shinyanga, where the various bush types, mbugas, clearings and secondary growths have been intensively studied by the Tsetse Department staff in relation to fly. After a fortnight in the Shinyanga area, including an expedition to Kahama, I spent a week each in the Bukoba and Mwanza districts in company with the agricultural officers there, visiting the agricultural school at Nyakato and the experimental stations at Nyamagono and Ukiriguru; then a further week in the cultivated eastern parts of Shinyanga, and a few days at Tabora, returning finally via Dar es Salaam to Amani in early February.

A report on this journey is in preparation. Apart from field notes and observations, and the fruits of discussions with tsetse, agricultural, veterinary and administrative officers, the material collected in the form of soil and rock samples and vegetation photographs amounts to some 450 numbers; and the whole will take some time to review for arriving at preliminary conclusions. The variety of uninvestigated soil phenomena that comes to notice even during a rapid two months' reconnaissance such as this leads me again to draw attention to the inadequacy of a staff of *one*, with one laboratory assistant, for soil survey in such a large area at this Station covers. The following pieces of work, for example each a considerable task for a field party with continuous laboratory support at headquarters, await attention along the route of this particular journey—which lay along main lines of communication only, through a part only of *one* of the six dependencies which nominally fall within Amani's scope :—

> Soils of the dry-forest (*Brachystegia* woodland) areas; Handeni, Tabora, Kahama, Uzinza. (Their genetics, morphology, chemical and physical characteristics and potential fertility.)

Soils of the deciduous thicket—dry-forest—mbuga complex : Kilimatinde escarpment, Manyoni, Itigi.

Soils of the low-lying plains : Wami plain, Bahi plain, Manyonga-Vembere steppe, Kagera valley, Mkata plain.

Soils of the xerophytic bush areas and open savanna woodlands : Handeni, Masai steppe, Ugogo, western Shinyanga.

Soils of primary formation on mountain slopes, inselbergs and granite kopjes.

Soils of the cultivation-steppe, Shinyanga-Mwanza, and soil protection problems arising under close native settlement, cotton, groundnut, millet and sorghum crops, and a dense cattle population.

The paradox of a dense population with a high export-production of coffee, located in an area of extremely poor laterized sandstone soils : Bukoba.

The relation of termites to soil formation and fertility : Tabora district especially, but the question arises in different forms everywhere.

There can be no doubt that the intrinsic interest and practical importance of such problems as these would justify the spending of a good deal more time in the field than has been possible hitherto. (This journey was the first occasion on which I have travelled west of Dodoma, or into the Western and Lake Provinces.) It is equally clear, however, that an extended field programme would cause arrears of laboratory work, and of preparation of results for publication, to mount up intolerably. At present there seems no alternative to leaving the study of many East African soil matters at the " reconnaissance " stage, without substantiation of the insecure conclusions that are reached at unimproved first acquaintance.

G. MILNE,
Soil Chemist.

REPORT OF THE BIOCHEMIST.

Insecticides.

Work on this subject has occupied the major portion of my time during 1935.

As reported last year the bark of *Mundulea suberosa* Benth., a plant indigenous to East Africa, showed promise of being nearly as toxic to insects as Derris root. A considerable volume of data has been obtained on this subject during the current year and a paper entitled " *Mundulea suberosa*, Benth., Part I, Insecticidal Properties " will be published in the May, 1936, number of the *Annals of Applied Biology*.

In the last report it was stated that the bark contains 0·8 to 0·9 per cent. rotenone : since then numerous other samples have been analyzed but none has contained more than 0·6 per cent. even when samples were taken from the same locality as the original.

This latter may be explained by the fact that it was an unusually dry year when the original sample was taken whereas the following year was slightly wetter than the average.

The natives at Moa, where these original samples were collected, state that two types of bark occur, one smooth which makes a good fish poison and one corky which is of no value. Such differences do occur in bark samples from various localities, and on the whole the insecticidal values are greater for the smooth barks than for the corky ones.

Both the Amani Botanist and the Kew authorities state that it is the same tree, *M. suberosa* Benth. in each case, but I am somewhat doubtful about this and am inclined to believe that two varieties exist.

Many of the samples contain no rotenone but are, nevertheless, somewhat toxic.

The majority of the insecticidal tests were made with the original sample containing 0·89 per cent. rotenone and it was compared with Derris root containing 5·4 per cent. rotenone and with nicotine.

A very large number of tests were made, 6,308 insects of various kinds being used in all. From curves obtained by plotting percentage kill against strength of insecticide the concentration required to produce just 100 per cent. kill was obtained. In the following table this concentration is given in the case of five different insects.

	Insect	*Mundulea bark*	*Derris*	*Nicotine*
		per cent.	per cent.	per cent.
1.	*Aphis tavaresi*	0.33	0.29	0.25
2.	*Toxoptera aurantii*	0.125	0.15	0.06
3.	*Citrus Psylla*	0.45	0.35	0.25
4.	*Brithys pancratii*	2.45	2.45	4.00
5.	*Orthezia insignis*	2.00	2.00	7.50

No. 4 is a caterpillar common in Amani and No. 5 is the so-called Lantana bug.

These results show that the Mundulea is on the whole as toxic as the Derris and the nicotine.

Used as a powder and dusted on to cockroaches and flies I found the Mundulea bark and Derris to be equal in effect: in addition both, in comparison with Pyrethrum although not producing the rapid knock-down effect, caused death in about half the time. Paraffin extracts behave in a similar way.

Mundulea seeds are about three-quarters as toxic as the bark but only quite small quantities are obtainable.

A considerable amount of work on the chemistry of the bark has been carried out but I am not yet in a position to report on this.

Experiments are in progress in cultivating Mundulea and the first trees are now a year old and growing well. It is proposed to try them in various localities, although present data tend to indicate a dry situation as producing the most toxic bark. By

selection it is hoped to obtain trees with higher rotenone content, and I also propose to determine the effects on toxicity of various artificial fertilisers.

Considerable difficulty was encountered in determining the amount of rotenone in Mundulea bark, but eventually a suitable method was devised and on the strength of the results obtained I am at present occupied with adapting this method to rotenone determinations in general, as it appears to be an improvement on all present methods in use. It is hoped to publish a paper on this subject shortly.

There is no doubt that vegetable insecticides, and particularly Derris, are coming more and more into prominence. Many parts of East Africa are particularly suitable for Derris cultivation and the world demands for it exceed by far the present production.

There are still, however, many problems in connexion with Derris which require elucidation, the major one probably being the method by which its toxicity can be assessed. Commercially both rotenone content and ether extract are in use but neither is reliable. Biological tests suffer from the great defect that, so far, it is impossible to rely upon production of the same result in different places under different conditions.

This problem and many others are on my programme for future investigation.

We have imported goldfish from England and Japan and are trying to breed them. If supplies permit I propose to investigate the relationship between toxicity to fish and to insects. A large number of reputed fish poisons have been tested biologically and gave no indication of usefulness as insecticides. If the goldfish breed well it will be of great interest to see how many of these reputed fish poisons are really toxic to fish.

Considerably more work on insecticides could be carried out if I had a laboratory assistant to undertake some of the many routine tests and analyses that are necessary.

Essential Oils.

No new essential oils have been discovered during the year.

The small plot of *Aframomum amaniense* is very patchy, some plants having grown well, whilst many have died. Work is continuing but there is some doubt whether the plant will thrive well under cultivation. Its natural habitat is the shady edges of the forest and it is therefore possible that it might do well under coffee or some similar crop.

The acre plot of lemon grass yielded eleven cuttings in twelve months, the yield and quality of oil being good in each case. The tufts of grass did not grow to the size expected however, so that the planting distances could have been reduced. A smaller plot has now been planted much more closely and a very good first cutting has been obtained : it is proposed to continue this experiment for a year or more.

The oil from the Ylang Ylang trees grown near the coast does not possess quite such a fine odour as that from our own plantations at Sigi, but should, nevertheless, be worth distilling.

A large amount of bitter orange leaves was distilled and the resulting Petitgrain oil forwarded to England for examination; the oil is of very high ester content and the yield is good. It is expected that commercial production will be instituted at Sigi Segoma.

Numerous small samples of various oils have been distilled but none is worthy of note.

Other Work.

During the year a paper entitled *Cinchona in Amani* was published in the Bulletin of the Imperial Institute. This paper deals with every aspect of the Cinchona planted in Amani, from 1902 to the present time.

As usual a certain amount of analytical work and tests of various descriptions have been undertaken during the year.

R. R. WORSLEY,
Biochemist.

REPORT OF THE PLANT PHYSIOLOGIST.

Coffee.

In my last annual report I indicated that it was probable that the transpiration of the coffee tree was controlled, to a great extent, by the negative pressures existing in the xylem vessels of the trunk. I have succeeded in definitely proving this, and further confirmation is afforded by recent work on other plants in Europe. This work considerably extends that done at Amani. Careful experiments have failed to show any stomatal movements associated with increasing negative pressures in the stem, although these pressures are accompanied by a reduction in the rate of water loss from the leaves. It would appear to be probable that the reduction in transpiration is caused by reduced vapour pressure at the transpiring surface of the mesophyll cell, possibly coupled with other " internal " phenomena tending to slow up the movement of water in the leaf.

The relation between the rate of uptake of water by the roots and the pressure deficit in the plant has so far remained unelucidated, although there appears to be a pressure at which the increase in water uptake for a given increment of pressure difference decreases. Lack of suitable plant material has hindered this work considerably. It will be taken up again when opportunity offers, possibly at the Coffee Research Station at Lyamungu.

Work has continued on the carbohydrate nutrition of coffee. Stomatal work at Amani has shown that, under local conditions,

complete closure of the stomata takes place during the middle of the day, unless clouds reduce the light intensity.

The implication is obvious. It would appear to be improbable that any exact relationship exists between photosynthesis and stomatal aperture, just as it has been proved that there is none between stomatal aperture and transpiration. Yet it is impossible to conceive of there being other than a reduction in assimilation when, as is the case with coffee, the stomata remain completely closed for a long period.

This reduction in the total amount of assimilate per day is a serious thing, especially in some districts where there is known to be a tendency to carbohydrate depletion in coffee. In order to carry the work to its logical conclusion it is necessary to show that the stomatal closure is, in fact, accompanied by a reduction in photosynthesis, and, if possible, to measure the diurnal march of photosynthetic rates throughout the day under a variety of field conditions.

Work has started on this problem, and a satisfactory technique appears to have been found. A stay of some months is being made at the Coffee Research Station at Lyamungu, where conditions are such that the probability of success is greater. Conditions are also more typical of the coffee-growing districts than are those at Amani.

A journey was made to Uganda in November for the purpose of investigating the root systems of *C. robusta.* I was unable to continue with this work owing to the incredible hardness of the deeper soil horizons in the coffee areas, which made excavation of the root systems a very lengthy process. The work is being carried on in Uganda with the Amani equipment by Dr. Griffith and Mr. Thomas. The results will probably be collated in conjunction with Amani.

The publication of the technique of resistance porometry last year made it possible to obtain records of greater accuracy than was feasible with the apparatus previously used. A new type of recording manometer has been developed at Amani for use with the resistance porometer, and previous results have been confirmed and extended.

I have been able to show that the mid-day closure of the stomata is not due to any effect of water shortage in the plant, nor, in all probability, to any temperature effect of solar radiation on the leaves.

A journey to the Arusha district was made for the purpose of measuring stomatal movements in that area. The results are similar for both the Burka area on light soil at 4,000 feet and for the Usa area on a heavier loam at 3,000 feet. They are as follows :—

1. When the stomata of a coffee plant are exposed to light of comparatively low intensity there is a direct correlation

between the incident total solar radiation and the stomatal aperture.

2. With high incident radiation the correlation is reversed, increase in radiation being accompanied by a decrease in stomatal aperture, and *vice versa*.

3. There is no correlation between leaf temperature and stomatal movements.

4. There appears to be no evidence in favour of the view that the mid-day closure is initiated by a water-deficit in the plant.

Records were taken in both shaded and unshaded situations. They show conclusively that under field conditions at Amani, at Burka, and at Usa the stomata of unshaded leaves of coffee are closed for a considerable part of the day during sunny days, but that under shade the stomata remain open throughout the day.

Sisal.

The provision for the decortication of single leaves of sisal, commented on in my last report, has opened a wide field for work, of which advantage has been taken. The data so far accumulated on sisal fibre has been reviewed to date, and a full account prepared for publication.

During the year a satisfactory recording apparatus for investigation of the ductile and elastic properties of sisal has been designed and made at Amani. The results of the work carried out with it are very interesting and suggestive.

An unstretched sisal fibre is ductile in that a permanent extension can be produced by loading. When this extension has taken place, however, the fibre is non-ductile and is perfectly elastic, the extension being conditioned solely by the stress, and being non-permanent. For low rates of loading the stress-strain curve is linear, and for high rates a narrow hysteresis loop is formed. Work is continuing on this.

An exhibit, illustrative of some of the Amani work, with especial reference to the length range of Agave fibres, has been prepared for the Fibre Exhibition at the Imperial Institute.

Memoranda and data having reference to sisal have been prepared for the Kenya Sisal Growers' Association; and an article on " Grading of Sisal Fibre " embodying recent data, was written for the *East African Agricultural Journal*.

F. J. NUTMAN,
Plant Physiologist.

REPORT OF THE GENETICIST.

I was absent on leave from July, 1935, until February, 1936. During my leave I attended the Imperial Botanical Conference in London, in August, and the International Botanical Congress at Amsterdam, in September.

By kind permission of the Director, Sir Daniel Hall, I was able to spend two months at the John Innes Horticultural Institution, Merton, studying cytology and cytological technique.

Coffee.

General.—During my absence the only work carried on in this section was the routine harvesting of the crop and the maintenance of the regular records.

Plots of *C. arabica* have been still further depleted by the inroads of the white stem borer, and dieback has been very marked this season although the crop has been moderate. Manured plots have not suffered to the same extent and are in moderately good health.

Arabica scions grafted on to stocks of the *robusta* and *liberica* groups, bearing their second crop, have suffered from dieback in a few instances. The plants which were grafted by inarching in the seedling stage in late 1931 and early 1932 have shown a considerable increase in the average yield per tree over that recorded in 1934. Scions of *arabica* grafted on to yearling stocks of *C. liberica* in February, 1932, have given a similar yield to that obtained in 1934 (an average of about 5 kilos fresh cherry per tree).

Robusta coffee continues to thrive but yields have not been maintained at the previous high level, mainly owing to a mistaken pruning policy put into effect in 1934.

Breeding.—*C. arabica* selections and breeding material now being grown at the Coffee Research and Experimental Station at Lyamungu have made very good progress during the year. The seed obtained by selfing *arabica* parents last season has also been sent up to Lyamungu and is now in the nursery.

Selected *robusta* parents outstanding for size and uniformity of bean and yield have been crossed, with a satisfactory set of fruits. The seed is showing a good germination.

The first generation of the interspecific cross *arabica* X *robusta* (CB 10) which last year produced one viable seed, has this year produced many fruits most of which proved abortive but a number of seedling plants have been raised. The plant raised from seed last year is now growing strongly after an uncertain start.

Cytology.—Krug* has shown for five varieties of *C. arabica* a chromosome number of 2n = 44, and that *C. canephora*, *C. congensis*, and *C. excelsa* have a somatic number of 2n = 22. My own observations of root tips of plants of an F1 *C. arabica* X *C. robusta* (CB 11.33) show a chromosome number of 2n = 33 and presumably CB 10 is similarly triploid. A closer study of this and other material has not yet been made.

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* Krug, C.A., Beitrag zur Cytologie des Genus *Coffea*. Züchter 1934: 6: 166-68.

Quality.—A further 30 samples of coffee have been sent to the Imperial Institute to be handed over to the tasters for liquoring tests. Consideration of the data derived from the tests of samples of last year's crop yields little to add to the comments in the last annual report. The material sent in this season included a series of identical samples and the results of the tests on these indicate the degree of variability which is to be expected in endeavouring to assess the liquoring qualities of any given sample. It is evident that a large number of idential portions of any sample would have to be sent for test and an average value found from the series of tests on each sample before any comparisons can be effected. The continuation of the investigations on these lines would entail an enormous amount of work for the taster and could not possibly be done under the present arrangement with the brokers at home.

Agaves.

Breeding.—The crosses which were effected last year between *amaniensis* and other species of Agave resulted in a good set of fruits and seeds but in two cases the germination was disappointing, i.e. where *amaniensis* was the female parent. A number of seedlings of these crosses and about 2,000 selfed seedlings of *amaniensis* have been raised and are growing vigorously.

Samples of leaf from 58 seedlings of *sisalana* have been decorticated and the fibre of the most promising plants subjected to tests of fineness and strength. A few of the seedlings tested show slightly better fibre characteristics than the parent form (grown under the same conditions) but the seedlings have the disadvantage of thorny leaf margins.

Blue sisal v. *sisal.*—The experiment laid down to compare the development and yield of *amaniensis* (Blue Sisal) and *sisalana* (Sisal) is now ready for cutting for the first time. The results will not be available for inclusion in this report. The plots of blue sisal are outstanding in appearance.

Cytology.—The results of the cytological examination of species of Agave have been presented for publication. Much work remains to be done on the other species represented in our collection and on the hybrid forms which have been raised at Amani.

Acknowledgments.

I have again to acknowledge much help from the Imperial Institute; Messrs. J. K. Gilliatt & Co., the Chief Scientific Officer, Lyamungu, the Agricultural Officer i/c Sisal Experiment Station, Ngomeni, and to acknowledge my indebtedness to all working at the John Innes Horticultural Institution, for making my stay there both profitable and pleasant.

L. R. DOUGHTY,
Plant Geneticist.

REPORT OF THE SYSTEMATIC BOTANIST.

Herbarium.

A total of 3,013 determinations was made on species received during the year and information supplied on the subjects listed in previous reports to a wide range of institutions and interested individuals in East Africa and other countries.

The Herbarium equipment has been supplemented by an electrical drying cabinet, constructed in the workshops at Amani. It is a most useful addition to my equipment in an area of high humidity, as it now takes only about a week to dry botanical material in its presses.

Messrs. Bally and Koritschoner, together with the Medical Department of Tanganyika Territory, are collecting and investigating the native medicinal and poisonous plants of the Territory; these are being determined at Amani.

The arrow poison plant, *Sapium madagascariense* Prain, referred to in the Annual Report for 1934-5* has been re-collected and material sent to the Analytical Chemist, Medical Department, Tanganyika Territory. He reports that extracts of the plant were injected into frogs and mice with negative results.

Collectors' field notes on specimens in the Amani Herbarium and additional native reports received through Messrs. Bally and Koritschoner, on the toxicity of *Agaurea salicifolia* Hook. f., a member of the Ericaceae, induced the Analytical Chemist of the Territory to examine the plant. He found it to be extremely toxic as stated by the natives and chemical investigations on it are being continued.

Photographs, outline drawings and descriptions were prepared of the main types of bananas in the Banana Trial Plot at Amani and forwarded to the Department of Agriculture, Uganda, for comparison with those grown in Uganda.

Suckers of these types were sent to the Royal Botanic Gardens at Kew for transhipment to Trinidad for the Banana Research work being carried out at the Imperial College of Tropical Agriculture.

The dictionary of Kiswahili plant names has been completed but requires a certain amount of revision. It proves to be too lengthy for inclusion in the Kiswahili-English Dictionary which is being published by the Inter-Territorial Language Committee and it is suggested that it be published separately.

Type species.

A further 34 isotypes have been found in the Herbarium during the year whilst determining specimens for various departments and individuals.

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* Colonial No. 110.

The following new species from the Herbarium have also been described :—

Anisotes bracteatus Milne-Redhead in Hook. Ic. Pl. t. 3268 (1935) Acanthaceae. Tanganyika Territory, Dodoma Province, Gulwe 2,800 ft. alt., 19/8/1930, *Greenway* 2407, type.

Blepharis Hornbyae Milne-Redhead Ic. t. 3266 (1935) Acanthaceae. Tanganyika Territory, Dodoma Province, Mpwapwa, 14/8/1928, *Mrs. Hornby* 1, type; Mpwapwa 3,400 to 3,700 ft. alt., 18/8/1930, *Greenway* 2401.

Pavetta dolichantha Brem. in Mon. *Pavetta* in Fedde Repert. 37 : 175 (1934) Rubiaceae. Tanganyika Territory, Dodoma Province, Mpwapwa, 5/4/1929, *Mrs. Hornby* 96, type.

These new species bring the total number of type specimens recorded in the Amani Herbarium up to 235 isotypes.

Contributions.

Eighty-four contributions of specimens were received during the year representing a total of 5,610 specimens for identification. They were received from the following institutions and individuals :—

The Conservator of Forests, Tanganyika Territory, collected by Messrs. Baldock, Bancroft, Markham and Pitt-Schenkel	75
The Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, collected by Messrs. Emson, Hornby, Lewys Lloyd and Staples	316
The Imperial Forestry Institute, Oxford	300
The Royal Botanic Gardens, Kew	846
The Medical Department, Laboratory Service, Tanganyika Territory	51
The Department of Agriculture, Tanganyika Territory, collected by Messrs. Harris, Ritchie, Ward, Davies, Gillman, Marsland, Swynnerton, Haarer and Cairns	1,930
The Veterinary Department, Uganda, collected by H. E. Lewys Lloyd, Esq.	16
The Coffee Research and Experimental Station, Tanganyika Territory, collected by C. B. Gibbins, Esq.	58
The Amani Staff	511
H. Koritschoner, Esq., Makuyuni, Tanganyika Territory	1,255
P. R. O. Bally, Esq., Tanga, Tanganyika Territory	203
Mrs. Audrey Moore, Musoma, Tanganyika Territory	32
Minor contributions from East Africa	17
Total	5,610

Exchanges.

Botanical material was exchanged with and distributed to the following institutions :—

From :	The Royal Botanic Gardens, Kew (named material collected in Uganda, Kenya and Tanganyika)	846
	The Imperial Forestry Institute, Oxford (named tree specimens from the Forest Departments of the British Colonies and Protectorates in Africa)	300
	Total received	1,146
To :	The Imperial Forestry Institute, Oxford ...	358
	The Analytical Chemist, Medical Department, Tanganyika Territory	6
	The Royal Botanic Gardens, Kew	1,053
	The National Herbarium, Pretoria ...	151
	Weston Bohn, Esq., University of Missouri, Columbia, U.S.A.	2
	S. C. Denston, Esq., Chelsea Polytechnic, London	3
	Total distributed	1,573

Field Work.

Collections of the local forest and grassland flora with ecological and economic notes are being continued.

The different forest species were demonstrated to Professor Troup, Director of the Imperial Forestry Institute, and Major Oliphant, Economic Adviser (Forest Products) to the Colonial Office, on their respective visits to Amani.

In September nearly a week was spent between the S. Pares and the northern end of the W. Usambaras in a search for fish poison plants with little success. The time was not wasted however as some interesting, little known and new, Stapelias, Carallumas and Notonias were collected.

A further period of about a week on the same quest was spent in October between the W. and E. Usambaras as far north as the southern edge of the Umba steppe with better results.

The results of these field observations are being published in the Kew Bulletin entitled " Mundulea Fish Poison ", an account of its botany, history, geographical range and uses, with ecological details.

Arrangements have been made with the Agricultural Department of Tanganyika Territory for a monthly supply of Mundulea bark

to be sent to Amani from between the S. and W. Usambaras. Further supplies are also being obtained through the Department of Veterinary Science and Animal Husbandry from Iringa and from Mr. B. D. Burtt, Survey Botanist, Tsetse Research, Shinyanga.

These samples of bark will enable the Biochemist to investigate the variability of the poison content, as its toxicity appears to vary considerably even from the same locality.

In January and part of February nearly six weeks was spent, part of the time accompanied by Mr. Moreau, in N. Masailand when Ketumbeine, Longido, Engare Naibor and Ol Donyo Sambu were visited; most of these places are botanically unexplored country; from Ol Donyo Sambu to the Moshi District, Lake Chala and Taveta and back by road by way of Himo, Lembeni, Same, Kisiwani, Mkomazi, Mombo, Muhesa.

Although weather conditions during the trip were far from favourable for botanical survey work a considerable amount of material was collected. It is estimated that it will take at least six months to work out the collections, in which there are a number of novelties.

A certain amount of time was also spent with Mr. B. D. Burtt, Survey Botanist, Tsetse Research, Tanganyika Territory, in demonstrating the various species in the evergreen rain forest and grassland areas around Amani. A visit with him, accompanied by the Soil Chemist, was also paid to an area north of Tanga, to demonstrate coastal Brachystegia Woodland on a Karoo Formation.

In conclusion, my thanks are due to Administrative, Agricultural, and Veterinary Officers of Tanganyika Territory, for their assistance when in the field.

P. J. GREENWAY,
Systematic Botanist.

ORNITHOLOGICAL WORK.

The study of geographical distribution and ecological relations has been continued as the main part of the year's work. Although the subjects are so closely complementary, it is convenient to maintain the distinction in this report. A third section covers the miscellaneous activities of the year. The accumulation of new material has reached embarrassing proportions.

Six new forms have been described from our collections (*Bull. B.O.C.*, Vol. 56, pp. 13-18, 1935).

PICIDAE.—*Yungipicus obsoletus crateri* Sclater & Moreau, from the Mbulu District.

PYCNONOTIDAE.—*Phyllastrephus orostruthus amani* Sclater & Moreau, from Amani.

TURDIDAE.—*Turdus olivaceus oldeani* Sclater & Moreau, from the Mbulu District.

ZOSTEROPIDAE.—*Zosterops virens mbuluensis* Sclater & Moreau, from the Mbulu District and North Paré.

ZOSTEROPIDAE.—*Zosterops virens meruensis* Sclater & Moreau, from Mt. Meru.

NECTARINIIDAE.—*Anthreptes pallidigaster* Sclater & Moreau, from Amani.

The Phyllastrephus and the Anthreptes are of unusual interest. The typical form of the Phyllastrephus, which is an anomalous "Bulbul" thought to show affinity with the Turdidae, is known only from a single specimen collected in 1932 a thousand miles away on Mt. Namuli in Portuguese East Africa. The Anthreptes is in coloration utterly unlike any other of its genus; and it is in any case remarkable that a species of Sunbird should have remained undiscovered for so long in this part of Africa.

Geographical Distribution.

The more I have learnt of the distribution and subspecific differentiation of birds, especially those confined to the "island" environments, Lowland Forest vestiges, Highland Forest and montane conditions generally, the more I have been struck by the remarkable nature of the facts and the problems they present. Numbers of such "island" environments in Tanganyika still remain wholly unexplored biologically, and I have found that it is impossible to forecast what birds exist on an unknown "island" even when the avifaunae of similar "islands" within fifty miles on either side have been ascertained. In fact, Tanganyika and especially its northern half appears to offer an unsurpassed field for the study of distribution in relation to past and present conditions, and of differentiation in relation to the degree of isolation within an ancient land-mass. With these materials it might be possible to obtain some indication of the relative importance of geographical distance and of unfavourable conditions, climatic and vegetational, in making effective the isolation that favours the evolutionary process.

A memorandum setting out these possibilities was forwarded by the Director to the authorities of the British Museum (Natural History). As a result they have agreed to finance such investigation on the lines indicated above as may be found possible during the next few years. The bulk of the collecting must of necessity be done by unaccompanied Africans. In the course of local leave and such other time as I can be spared from my routine duties, I hope to make on the average one journey a year devoted to the ecological observations without which the results of the collecting cannot be interpreted. The project has been brought nearer to realization by the enthusiastic co-operation of Mr. E. G. Rowe, who has exceptional opportunities for arranging work in some of the more inaccessible spots on my programme.

Collecting during the year has been directed to (i) tracing the peculiar avifauna of the East African coastal strip inland; (ii)

working the South Paré montane more adequately; (iii) an examination of Ketumbeine and Longido Mountains—

(i) Between the coastal strip (including the East Usambara foothills) and the Lowland Forest area furthest inland, which is that at the base of Kilimanjaro, Lowland Forest appears to survive only at Mombo. Mnazi (West Usambara; both vestigial) and Gonja (South Paré). The birds of all these "islands" are now, I think, adequately known. They are practically identical with those of the Kilimanjaro Lowland, and from all of them the endemics of the East African coast, *Anthus sokokensis*, *Anthreptes yokanae*, *Choropetella holochlorus* and many more, are absent.

(ii) The birds of the North and South Paré Mountains, wholly unknown two years ago, have been worked with some completeness, though I have not yet been able to visit the mountains personally. The results have been briefly summarised in "A Zoogeographical Note on the Birds of the Paré District."

(iii) I visited Ketumbeine and Longido Mountains, where no collecting has been done before, in January, 1936. The birds of the latter are I think now fairly completely known, but further work is needed on Ketumbeine. As expected the avifaunae are not rich, but they show certain surprising differences from Mt. Meru, only 40 miles away, and from each other.

My paper, "A Contribution to the Ornithology of Kilimanjaro and Mt. Meru," has appeared in *Proc. Zool. Soc., London*, 1935, pp. 843-891. It concentrates on the birds found above 4,000 feet. Since it was written some further work has been done at the foot of both mountains and the Meru list supplemented.

A paper dealing with the Mbulu District collections referred to in last year's report has been prepared.

Ecological Work.

Periodical visits to Mkomasi have been made, and it is intended to maintain them in order to get a thorough grasp of the phenology and seasonal ecology of the locality, which is typical of a large area of semi-arid East Africa. Not only the seasonal nature of the birds' activity, but also the seasonal fluctuations in the bird population are comparable rather with those of the temperate zones than those of Equatorial Africa.

Thanks to the co-operation of the Tanganyika Railway authorities and the British East African Meteorological Service rainfall records have been started at Mkomasi in connection with this study.

Some further examination of bird stomachs has been done during the year by Mr. W. Nowell. It is hoped to present shortly the results of the work on about 200 specimens of Weavers (*Ploceus aureoflavus* and *P. nigriceps*), 20 Nightjars and 20 Honey-guides.

1,450 stomachs from a wide range of species are available for examination if the necessary expert assistance is ever forthcoming.

With the publication of my " Critical Analysis of the Distribution of Birds in a Tropical African Area " (*J. Animal Ecol.*, pp. 167-191, 1935) the series I originally projected on the ecology of Usambara birds generally has been completed. It was planned as a contribution to one of the central problems of ornithology, namely, what factors determine distribution. Data are being accumulated for an approach to the problem from other angles (i) through the mutual ecological relations of closely allied birds, e.g., the 23 members of the Shrike family (*Laniidae*), in the comparatively small area of Usambara; (ii) by comparing the conditions under which Palaearctic birds winter in Africa with those of their summer quarters.

Miscellaneous.

As mentioned in an earlier Annual Report, there is very little on record regarding the breeding seasons of birds—or indeed the seasonal activity of any organisms—in low latitudes and more especially in evergreen environments. The gonad size and the plumage state are recorded for all birds collected for this Research Station. These particulars form a most valuable supplement to field observations. The data obtained from these various sources during the past few years have now been analysed and discussed in a paper " Breeding and Moulting Seasons of Birds in Evergreen Environments in East Africa," which has been accepted for publication by the Zoological Society of London.

During the year further opportunities have presented themselves for the investigation of the breeding biology of Hornbills, whose habits are the most extraordinary of any African birds. Thanks to the co-operation of several observers, the essential facts are now known for two species of Lophoceros as well as for *Bycanistes cristatus*. Interesting generic differences are revealed; in particular the remarkable fact that in Lophoceros the female leaves the young when they are only about three weeks old and they replace the broken plaster using similar materials and method to their mother's. So far as I am aware, such technology in nestling birds is unique.

Life-histories of several Weavers have received special attention. The Little Red Bishop, *Euplectes nigroventris*, exhibits an extreme development of the " territorial " instinct which is most interesting. It seems certain that as many as nine broods may be reared in the territory of a single male in the course of a season which lasts only about four months. Yet adult males that do not possess " territory " are few. This raises the interesting possibility that there may be a genetical sex-disproportion. Nestlings have been collected and through the kind offices of Mr. N. B. Kinnear their sexing, which presents technical difficulties, is being arranged in the United Kingdom.

In the course of the last few years' field work and examination of specimens a mass of new material has been accumulated which finds no place in the studies reported above. A selection has been prepared for publication under the title "Biological and Other Notes on Some East African Birds."

R. E. Moreau.

REPORT OF THE SUPERINTENDENT OF PLANTATIONS.

The Engineer, Mr. T. V. Greenwood, was absent from the Station on vacation leave from May, 1935, until January, 1936. During this period the supervision of the artisan staff was added to the work of the Superintendent.

Construction and Maintenance.

The completion of the building comprising the General Office, Secretary's Office, Storerooms, Post Office and the Geneticist's Laboratory constituted the chief item under this heading.

An extension was built to the soil-store adjoining the Soil Laboratory.

Necessary maintenance and repairs to quarters were carried out while the officers were on vacation leave.

A new 4,000-gallon water-tank was constructed at Forest House, and the west end of the bachelors' quarters partly rebuilt.

Transport.

An efficient transport service was maintained throughout the year without further purchase of vehicles. Necessary repairs were carried out as usual in the Station workshops.

Roads.

The maintenance and improvement of the Amani-Muhesa road has been continued under the control of the Station.

Kwamkoro Estate.

Work on the old coffee plantations again consisted only of cleaning through with bushknives and the harvesting of the crop. Eight tons of clean *Coffea arabica* and one ton of *Coffea robusta* were harvested. The new *C. robusta* plots planted up from selected seed mentioned in previous reports are doing well.

Good progress has been made under the scheme for the development of Kwamkoro Estate, as proposed by the Director and financed from the Colonial Development Fund. Considerable areas of old coffee plantations have been cleared and work on the establishment of the following economic crops carried out :—

Tung Oil trees.

Fifty-five acres have been planted with *Aleurites montana* and promise well. A further 100 acres have been cleared for the extension of the area during the coming year.

Cinchona.

An area of aproximately 85 acres has been cleared for Cinchona planting. A nursery at the end of this area has been prepared and planted with 20,000 *Cinchona ledgeriana* and 10,000 *C. succirubra* seedlings. Many of these are now ready for planting out. Unfortunately a virulent disease, hitherto not met with in this area, has lately attacked the young plants. Approximately 25 per cent. have died. Investigations as to the identity and control of this disease are proceeding.* In the meantime the transplanting of young seedlings from Amani into this nursery has been stopped.

Coffea robusta.

The remainder of the Mlesa plantation, approximately 80 acres, has now been cleared for planting with the selected *Coffea robusta* plants mentioned in the last report. A large number of seedlings raised at Amani are now being transplanted into the nursery extension near the factory for refills and extension.

Tuba Root.

Six thousand plants of *Derris elliptica* have been planted out and are growing well. It is intended to increase considerably the planting of this crop between the rows of *Aleurites montana* as soon as planting material becomes available.

Animals.

New animal sheds have been built. Forty-nine heifers, two bulls and six young oxen were purchased through the Stock Inspector, Korogwe. One bull and one heifer died soon after their arrival. The remainder are doing well.

Plantations and Nurseries.

The work of raising economic plants and seeds for distribution to Agricultural Departments and planters and for planting on the Kwamkoro Estate has again reached considerable magnitude. The growing and collecting of material for the Bio-chemist's investigations of insecticides and essential oils has been continued.

Tung Oil.

The plots of *Aleurites montana* at Amani continue to do well. The two trees left in the original nursery bed are again bearing a heavy crop. A few trees planted out in the Station grounds are also fruiting. It is estimated that 10,000 seeds will be available this year for raising plants for the extension of the plantation at Kwamkoro.

A few plants of *Aleurites Fordii*, although still not making any considerable growth are fruiting for the first time.

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* Preventive measures taken are later reported to be completely effective.—W.N.

Cinchona.

Twenty thousand *Cinchona ledgeriana* and 10,000 *C. succirubra* plants have been raised at Amani and transferred to the nursery at Kwamkoro. A further 30,000 *C. ledgeriana* and 20,000 *C. succirubra* seedlings have been pricked out into beds. These will be transferred to Kwamkoro as soon as a new nursery has been prepared. A large number of seedlings in the seed boxes are now ready for pricking out. No difficulty with the germination of Cinchona has been encountered.

Sisal and other Agaves.

Planting material of *Agave amaniensis* comprising 14,282 suckers and 47,124 bulbils was distributed. Seventy-five plants are now poling and a large increase of the distribution of bulbils during the coming year is anticipated.

Nursery work with Agaves has consisted chiefly in raising the hybrids of Agave species and selfed seedlings of *A. amaniensis* for the Geneticist.

Additions to the Agave collection at Amani, made possible by the introduction of Agave plants and seeds by Colonel the Hon. T. W. Boscawen, are as follows :—

Plants : *Agave affinis*, *A. connochaetodon*, *A. cerulata*, *A. desertii*, *A. datylio*, *A. elongata*, *A. goldmanniana*, *A. heteracantha*, *A. horrida*, *A. lurida*, *A. margaritae*, *A. nelsonii*, *A. nicholsae*, *A. orcuttiana*, *A. roseana*, *A. salmiana*, *A. sebastiana*, *A. striata*, *A. toumeyii*, *A. utahensis*, *A. wislizonii* and two unnamed species.

Seedlings : *A. albicans*, *A. ghiesbreghtii*, *A. chiapensis*, *A. lechuguilla*, *A. picta*, *A. rupicola*, *A. schidigera*, *A. warelliana*.

Coffea.

The inarching of one year old *Coffea arabica* on old *C. robusta* and *C. liberica* stocks again proved successful. The following percentages were obtained—on *C. robusta* (hybrid), 92 per cent., *C. robusta* 84 per cent., *C. bukobensis* 81·2 per cent., and *C. excelsa* 95 per cent.

The inarching of one year old *C. arabica* on *C. robusta* stocks of the same age for eventual planting out at Kwamkoro has been commenced; 3,000 plants have been completed. Of the earlier inarchings approximately 95 per cent. have grown.

Ramie.

Fourteen cwt. of root divisions of Ramie were supplied to planters during the year. To meet the increasing demand for this plant, plots of *Boehmeria nivea* have again been planted up to provide material for future distribution.

Arrowroot.

Three cwt. of Arrowroot rhizomes were supplied during the year. The plot has been replanted with suckers.

Cover Crops.

Seeds of the remainder of the cover crop species from the Amani collection have been sent to the Coffee Experimental Station, Lyamungu. The growing of cover crops for seed distribution has now been given up.

Yerba Mate—Ilex paraguensis.

The Paraguay tea, mentioned in the last report as sent to England for trial purposes, did not prove successful. The price obtained barely paid expenses. Preparation carefully adjusted to British standards is required.

Plant Quarantine.

Cassava.

Two varieties have been introduced from Java, two from Zanzibar and three from Kenya.

Succulents.

Seven collections of succulents, totalling 886 plants, imported by Colonel the Hon. T. W. Boscawen were received into quarantine. With the exception of *Agave spp.* most of these have now been released. Colonel Boscawen has kindly handed over to the station all Agaves not previously represented in the Amani collection (see under Sisal).

Orchids.

Two collections were imported by Colonel Boscawen and presented to the Station.

Sugar Cane Varieties.

Mayaguez 7 has now been transferred from the plant reception house to the observation house.

Uba Varieties.

A special consignment of 18 cuttings imported by the Plant Pathologist from India for experimental studies are being retained in the reception house.

All canes mentioned in the last report in the observation house have now been released to open quarantine.

The following is a complete list of canes at Amani :—

P.O.J.2727, P.O.J.213, P.O.J.2714, P.O.J.2725, P.O.J.2878, BH.10/12, B.891, B.3013, B.726, B.3172, B.3254, B.3257, B.2935, B.A.11403, B.A.11569, H.M.606, H.M.320, R.P.8, Mayaguez 702, Mayaguez 42, Mayaguez 7, Uba, C.O.205 and C.O.213.

Plant and Seed Importation.

Ninety-six packets of seeds and eight miscellaneous plants not otherwise listed.

Plant and Seed Distribution.

280 Miscellaneous plants, 358 packets of seeds, 164 cuttings, 30 suckers, 6 bulbs, 14,282 *Agave amaniensis* suckers, 47,124 *A. amaniensis* bulbils, 100 *A. sisalana* bulbils, 350 lb. Arrowroot rhizomes, 20 boxes Khus Khus roots, 6 Cacao fruits, 4¾ lb. *Coffea robusta*, 4 oz. *C. quillon*, 1 lb. *C. bukobensis*, 26 lb. *C. arabica*, 21¼ oz. Cinchona seed, 50 lb. Tea seed, 11 lb. Kapok seed, 27 lb. Ginger rhizomes, 61 lb. *Maesopsis Eminii seed*, 5 lb. *Cassia siamea* seed, 2 lb. *Aberia caffra* seed, 1 lb. *Allanblackia Stuhlmannii* seed, 1 lb. *Cinnamomum zeylanicum* seed, 1,590 lb. Rauvolfia root divisions, ½ lb. Cardamon seed, 3 lb. *Podocarpus usambarensis* seed, 1 lb. *Cajanus indicus* seed, 1 lb. *Cola vera* seed, 1 lb. *Tephrosia candida* seed, ½ lb. *Jacaranda ovalifolia* seed.

F. M. ROGERS,
Superintendent of Plantations.

REPORT OF THE SECRETARY AND LIBRARIAN.

The Assistant Secretary, Mr. W. M. Nutter, was on leave until 30th November. Miss K. Rushworth, Stenographer, resigned on 17th September, and was replaced by Mr. R. Bergner, appointed under Local Civil Service conditions. A number of causes have contributed to keep the office staff working at full pressure during the period under review: the increasing volume of typing directly concerned with scientific work; the rise in the number of periodical publications reaching the library; the development of Kwamkoro Estate; and the fact that the *East African Agricultural Journal* is edited from this Station.

I acted as Secretary of the Agricultural Research Conference held at Amani in February, 1936, and the report was prepared here.

During the year the expansion of the library has been satisfactory. About 30 new periodical series have been received for the first time, practically all of them by exchange; several important series of back numbers have been obtained with the aid of funds derived from the Carnegie Endowment; and 83 books have been added.

The printed catalogue mentioned in last year's report was distributed in April. Enough copies were supplied to the agricultural departments of the contributing dependencies to permit of one being retained at each departmental station; and in addition copies were supplied to all the departments in East Africa concerned with any aspect of scientific research. It is the intention to publish a supplement shortly in which the more important accessions will be listed.

R. E. MOREAU.
Secretary and Librarian.

APPENDIX A.

FINANCIAL STATEMENT FOR THE YEAR ENDED 31st DECEMBER, 1935.
EAST AFRICAN AGRICULTURAL RESEARCH STATION
(EXCLUDING KWAMKORO).

Revenue.

	£	£
Ordinary Recurrent Revenue:—		
H.M. (Imperial) Treasury	6,000	
Contribution, Tanganyika Territory	6,000	
„ Uganda	1,800	
„ Kenya	1,700	
„ Zanzibar	1,200	
„ Northern Rhodesia	300	
„ Nyasaland	300	
	17,300	
Local Sales, &c.	435	
Total		17,735
Extraordinary Revenue:—		
Levy on Salaries, 1st Jan. to 31st Oct., 1935...	541	541
		£18,276

Maintenance Expenditure.

	£	£
Personal Emoluments	11,027	
Passages	597	
Pensions Contributions	1,940	
Laboratories	919	
Library and Publications	429*	
Office, Telephone Rent, and Contingencies ...	251	
Materials	369	
Freight and Transport	343	
Travelling	550	
Labour	1,306	
		17,731
Balance on the year's working		£545†

* Additions to the Library have also been purchased out of the income from the Carnegie Trust Fund.

† *NOTE.*—This balance of £545 is made up as follows:—

Nominal Savings.	£	£
"Personal Emoluments—Pay" underspending owing to booking adjustments between years	180	
"Passages", underspending incidental to the arrangement of the leave programme ...	183	
Total nominal savings		363
Actual Savings.		
"Passages", due to de-grading of accommodation after the 1935 Estimates had been prepared	118	
"Other charges", small savings under several heads	64	
		182
Amount of actual savings		£545

Summary.

Recurrent Revenue	17,735	
Extraordinary Revenue	541	
Reserve on 1.1.1935	2,986	
		21,262
Maintenance Expenditure	17,731	
Expenditure from Reserve:—		
Reconstruction of buildings	493	
Electrical renewals	58	
		18,282
Credit balance on 31.12.1935		2,980
Expenditure approved from Reserve, but purchase not completed in 1935:—		
Hydro-Electric Plant	1,250	
Electrical Renewals	40	
		1,290

APPENDIX B.

FINANCIAL STATEMENT FOR THE YEAR ENDED 31st DECEMBER, 1935 (KWAMKORO ESTATE).

Hitherto this estate has been devoted to coffee only and its expenditure in successive years has been dependent on the proceeds of the previous years' crops. From 30th September, 1935, Kwamkoro has changed its status: it is now being developed by the aid of a grant from the Colonial Development Fund, and the activities connected with its original coffee plantations form an increasingly unimportant fraction of the whole. For the year under review it is possible, and worth while, to retain in the accounts the distinction between the working of the old plantations and the development of the new, but hereafter they will be merged.

OLD PLANTATIONS.

Receipts:—	£	£
Sale of Coffee (mostly 1934 Crop)	870	
Credit balance on 1.1.1935	167	
		1,037
Expenditure:—		
Crop expenses	163	
Other „	270	
		433
Accrued balance		£604

NEW DEVELOPMENT.

Receipts:—	£
Colonial Development Fund Grant	5,000
Expenditure:—	
3 months in 1935	1,004
Balance	£3,996

APPENDIX C.

LIST OF PUBLICATIONS DISTRIBUTED UP TO 31st MARCH, 1936, BY THE EAST AFRICAN AGRICULTURAL RESEARCH STATION.

1. Records of Butterfly Migration in East Africa. C. B. Williams, *J. E. A. & Uganda Nat. Hist. Soc.*, No. 35, pp. 1-16, 1929.

2. Collected Records relating to Insect Migration, First and Second Series. C. B. Williams, *Trans. Ent. Soc., London*, Vol. 77, pp. 79-91, 1928; Vol. 79, pp. 139-170, 1930.

3. Locust-hoppers and Birds in East Africa. R. E. Moreau, *Bull. Ent. Res.*, Vol. 21, Part 2, pp. 141-145, 1930.

4. The Bird-population of a Settled Valley in the West Usambaras, Tanganyika Territory. R. E. Moreau, *J. Ecol.*, Vol. 19, No. 1, pp. 64-74, 1931.

5. The Filtration of the Virus of Streak Disease of Maize. H. H. Storey, *Ann. Appl. Biol.*, Vol. 19, No. 1, pp. 1-5, 1932.

6. The Estimation of Carbon in Plant Tissues, R. R. Worsley & F. J. Nutman, *Ann. Bot.*, Vol 45, pp. 693-707, 1931.

7. A Bark Disease of Coffee in East Africa. H. H. Storey, *Ann. Appl. Biol.*, Vol. 19, No. 2, pp. 173-184, 1932.

8. Vegetation of Mpwapwa, Tanganyika Territory. P. J. Greenway, *J. Ecol.*, Vol. 21, No. 1, pp. 28-43, 1933.

9. Pleistocene Climatic Changes and the Distribution of Life in East Africa. R. E. Moreau, *J. Ecol.*, Vol. 21, No. 2, pp. 415-435, 1933.

10. On the Food of the Red-billed Oxpecker. R. E. Moreau, *Bull. Ent. Res.*, Vol. 24, Part 3, pp. 325-335, 1933.

11. The Inheritance by an Insect Vector of the Ability to Transmit a Plant Virus. H. H. Storey, *Proc. Roy. Soc. B.*, Vol. 112, pp. 45-60, 1932.

12. A Sulphur-deficiency Disease of the Tea Bush. H. H. Storey, *Ann. Appl. Biol.*, Vol. 20, Part 1, pp. 23-56, 1933.

13. A Note on the Distribution of *Gypohierax angolensis* (Gmel.), the Vulturine Fish-eagle. R. E. Moreau, *J. Animal Ecol.*, Vol 2, No. 2, pp. 179-183, 1933.

14. Observations on the Desert Locust in East Africa from July, 1928, to April, 1929. C. B. Williams, *Ann. Appl. Biol.*, Vol. 20, No. 3, pp. 463-497, 1933.

15. A Contribution to Tropical African Bird-Ecology. R. E. Moreau, *J. Animal Ecol.*, Vol. 3, No. 1, pp. 41-69, 1934.

16. A Chemical Survey of the Waters of Mount Meru, Tanganyika Territory, especially with regard to their qualities for Irrigation. D. Sturdy, W. E. Calton and G. Milne. *J. E. A. & Uganda Nat. Hist. Soc.*, No. 45, pp. 1-38, 1933.

17. Investigations of the Mechanism of the Transmission of Plant Viruses. H. H. Storey, *Proc. Roy. Soc. B.*, Vol. 113, pp. 463-485, 1933.

18. Root-systems of *Coffea arabica*, Parts I and II. F. J. Nutman, *Emp. J. Exp. Agric.*, Vol. 1, pp. 271-284, 285-296, 1933.

19. Taxonomic and Field Notes on Some Birds of North-East Tanganyika Territory. W. L. Sclater and R. E. Moreau, *Ibis* (Ser. 13, Vol. 2), pp. 487-522, 656-683, 1932; (Ser. 13, Vol. 3), pp. 1-33, 187-219, 399-440, 1933.

20. Some East African Essential Oils. R. R. Worsley, *Bull. Imp. Inst.*, Vol. 32, pp. 253-270, 1934.

21. The Insecticidal Properties of some East African Plants. R. R. Worsley, *Ann. App. Biol.*, Vol. 21, pp. 649-669, 1934.

22. Root-systems of *Coffea arabica*, Part III. F. J. Nutman, *Emp. J. Exp. Agric.*, Vol. 2, pp. 293-392, 1934.

23. The Photodynamic Action of Methylene Blue on the Virus of a Plant Disease. H. H. Storey, *Ann. Appl. Biol.*, Vol. 21, pp. 588-589, 1934.

24. Some Eco-climatic Data for Closed Evergreen Forest in Tropical Africa. R. E. Moreau, *J. Linn. Soc. Zool.*, Vol. 39, pp. 285-293, 1935.

25. A Synecological Study of the Usambara Mountains, Tanganyika Territory, with particular reference to Birds. R. E. Moreau, *J. Ecol.*, Vol. 23, pp. 1-43, 1935.

26. Cinchona in Amani. R. R. Worsley, *Bull. Imp. Inst.*, Vol. 33, pp. 14-31, 1935.

27. Some Suggested Units of Classification and Mapping, particularly for East African Soils. G. Milne, *Soil Research*, Vol. 4, pp. 183-198, 1935.

28. Studies on the Ecology of Coffee Plantations in East Africa, I: The Climate and Eco-climates of Coffee Plantations. T. W. Kirkpatrick, Publ. by the Crown Agents for the Colonies, London, 1935.

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